Fe55 CTE Update

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Goals

- Looking at Fe55 data from e2v-113 detector
- Hoping to characterize CTE/CTI for each section of detector
- Analyzing how flux changes across section
- Examine footprint-finding parameters for optimization
- Model found footprints as function of growth parameter

Charge Transfer Efficiency/Inefficiency (CTE/CTI)

- CTE is measure of how efficiently the device transfers charge packets between pixels
- CTI is measurement of how inefficiently any single transfer is, defined by CTI = 1-CTE
- CTI is obtained by examining change in flux across sections of detector

J.R. Janesick, *Scientific Charge-Coupled Devices,* SPIE Press, Bellingham, WA, (2001)

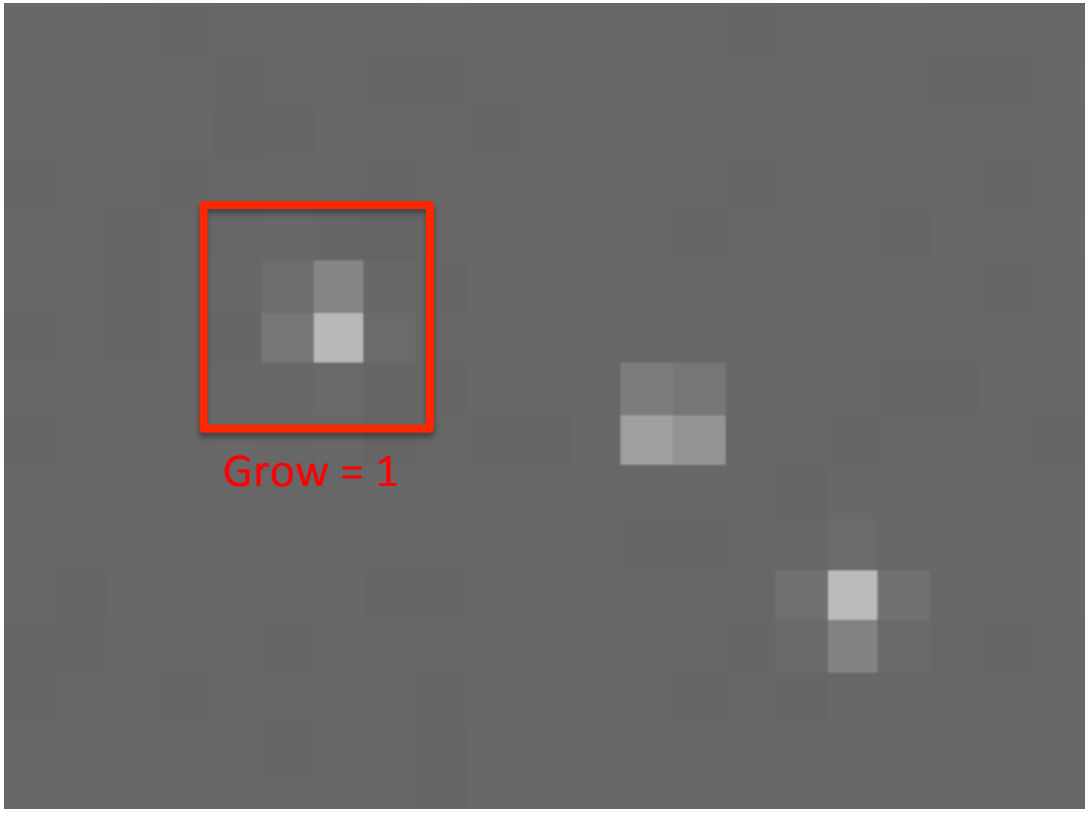
Fe55

- Iron-55 decays to manganese-55 via electron capture
  - Subsequently gives off 1 of 2 different energy x-rays during capture
  - Kα (5.9keV) x-rays are much more likely than Kβ (6.5keV) x-rays
- X-rays carry enough energy to inject e- into CCD via photoelectric effect
  - Known to deposit ~1600 e- into CCD, with about 70% within a pixel suffering hit directly in center

J.R. Janesick, *Scientific Charge-Coupled Devices,* SPIE Press, Bellingham, WA, (2001)

Footprint Finder

- Searches for minimum number of adjacent pixels above given threshold
- Once all pixels above threshold found, extends region by growth factor in each direction

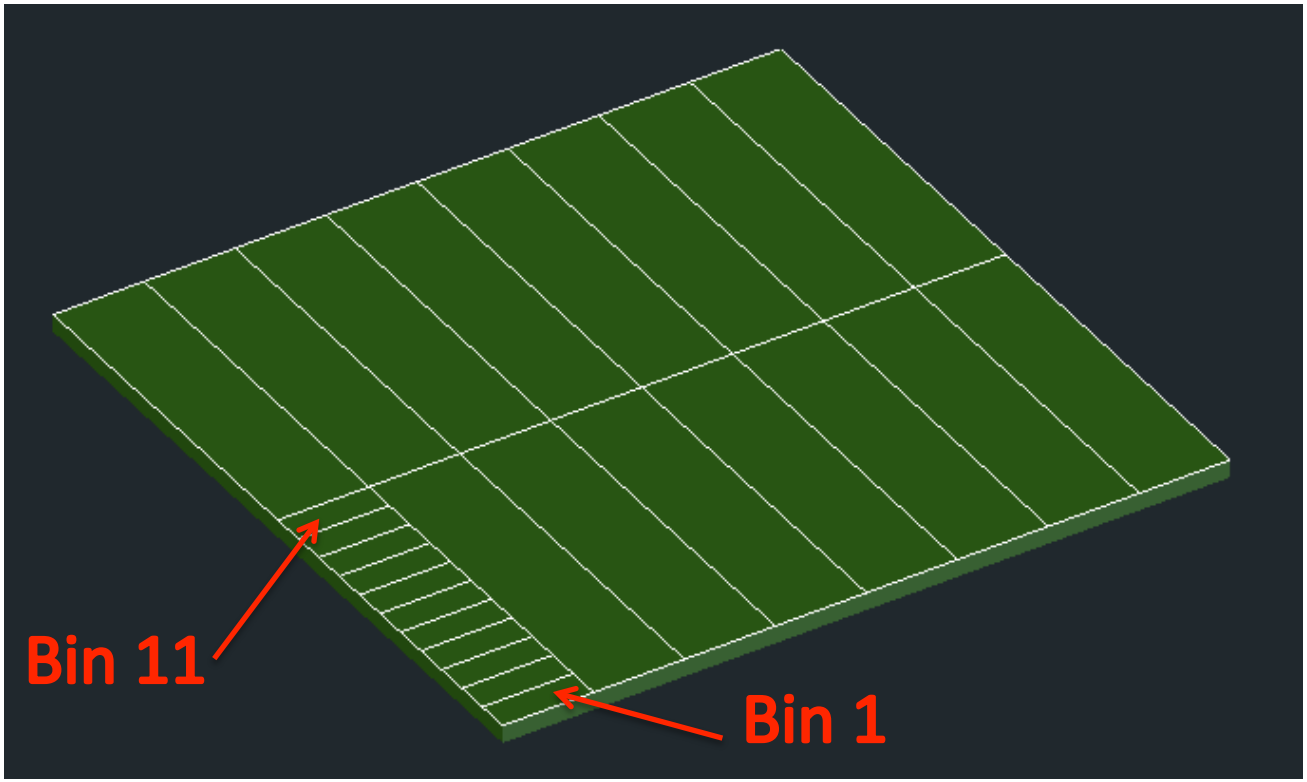


Flux analysis

- Examining how flux changes across each detector
  - Divide each section into 11 bins
  - Determine flux in each bin of section
  - Plot flux vs bin to determine how it changes
- Looking for flux to decrease as bins get farther from serial amp
- Change in flux directly relates to inefficiency of charge transfers

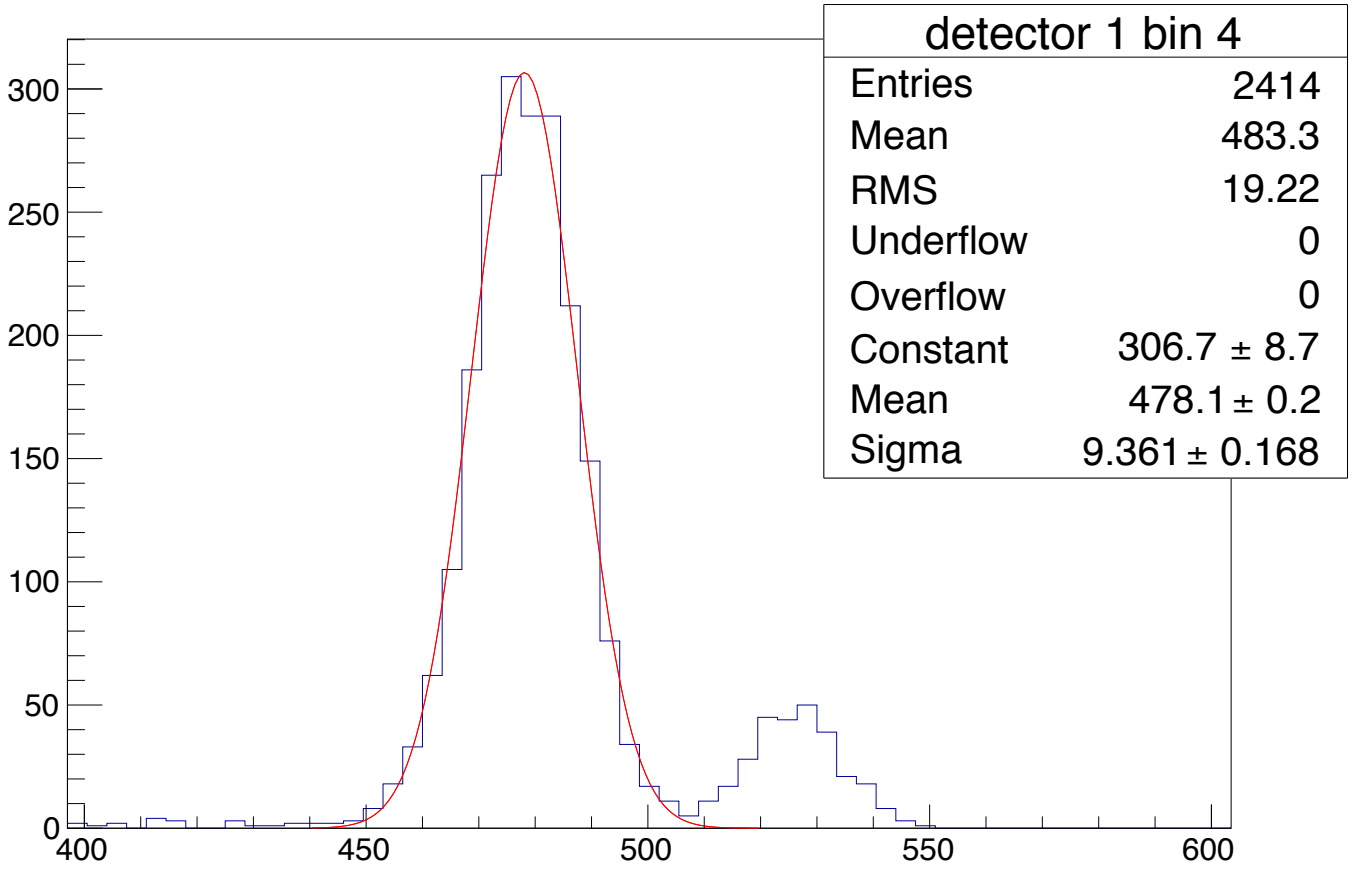
Section Binning

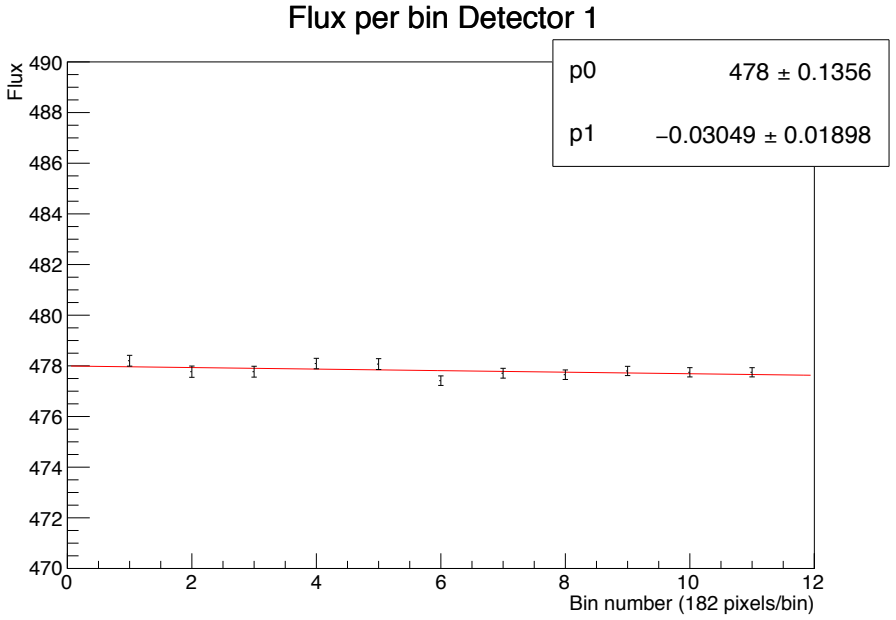
- Each section contains 11 bins of 182 pixels/ bin
- Bin number increases farther away from serial amp

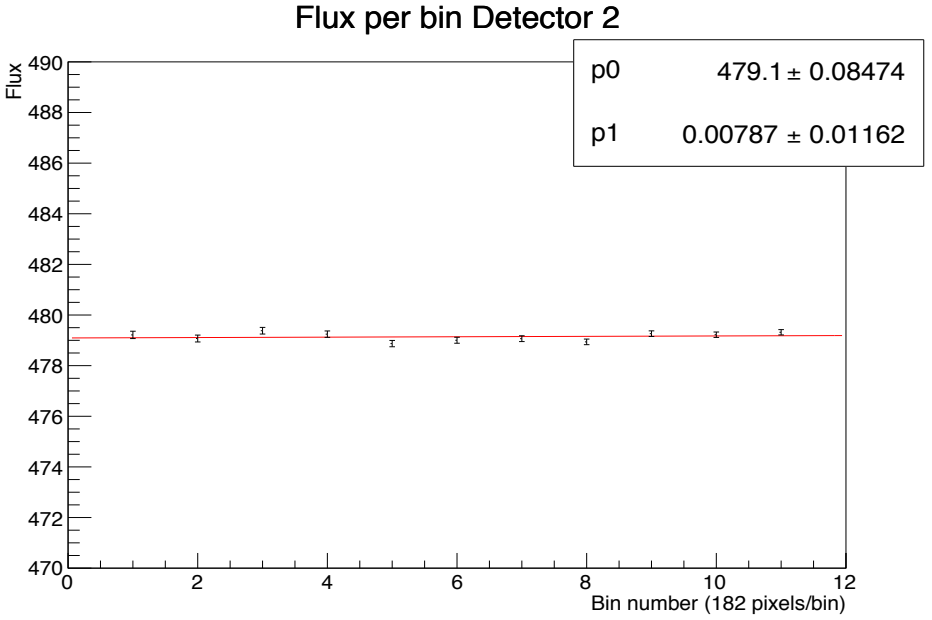


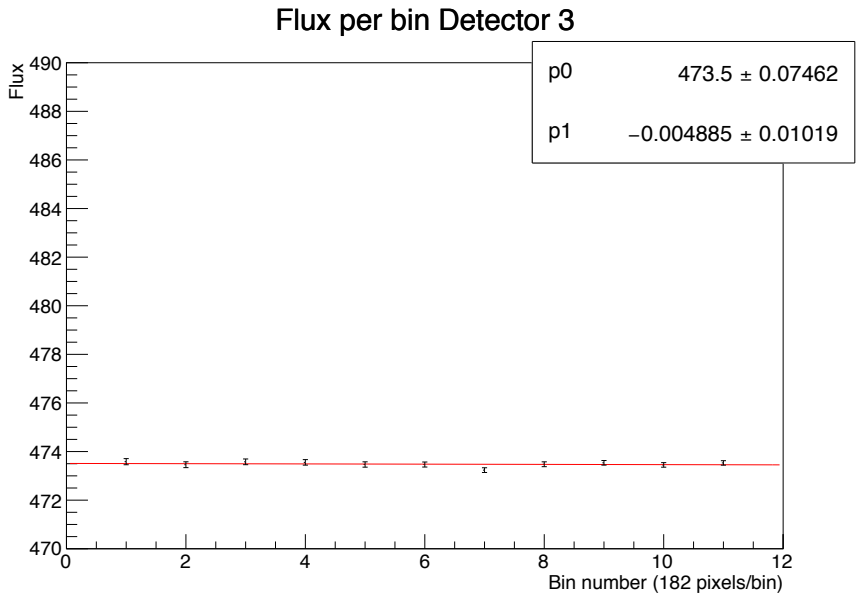
Determining Flux

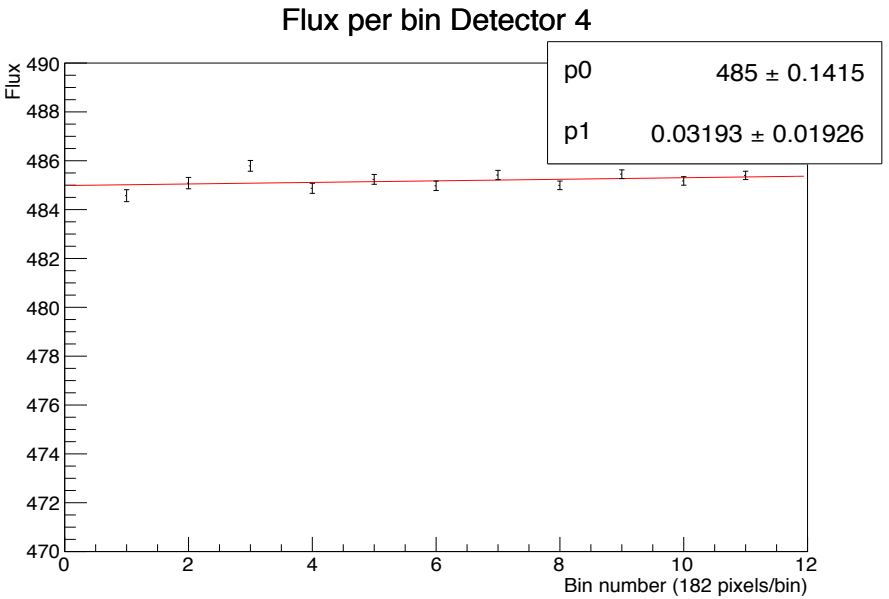
- Fit gaussian to Kα peak to determine mean flux in each bin
  - Originally fit double gaussian to both peaks, low statistics in Kβ peak made single fit workable
- Mean flux for each Kα peak in each bin used to determine change in flux across section



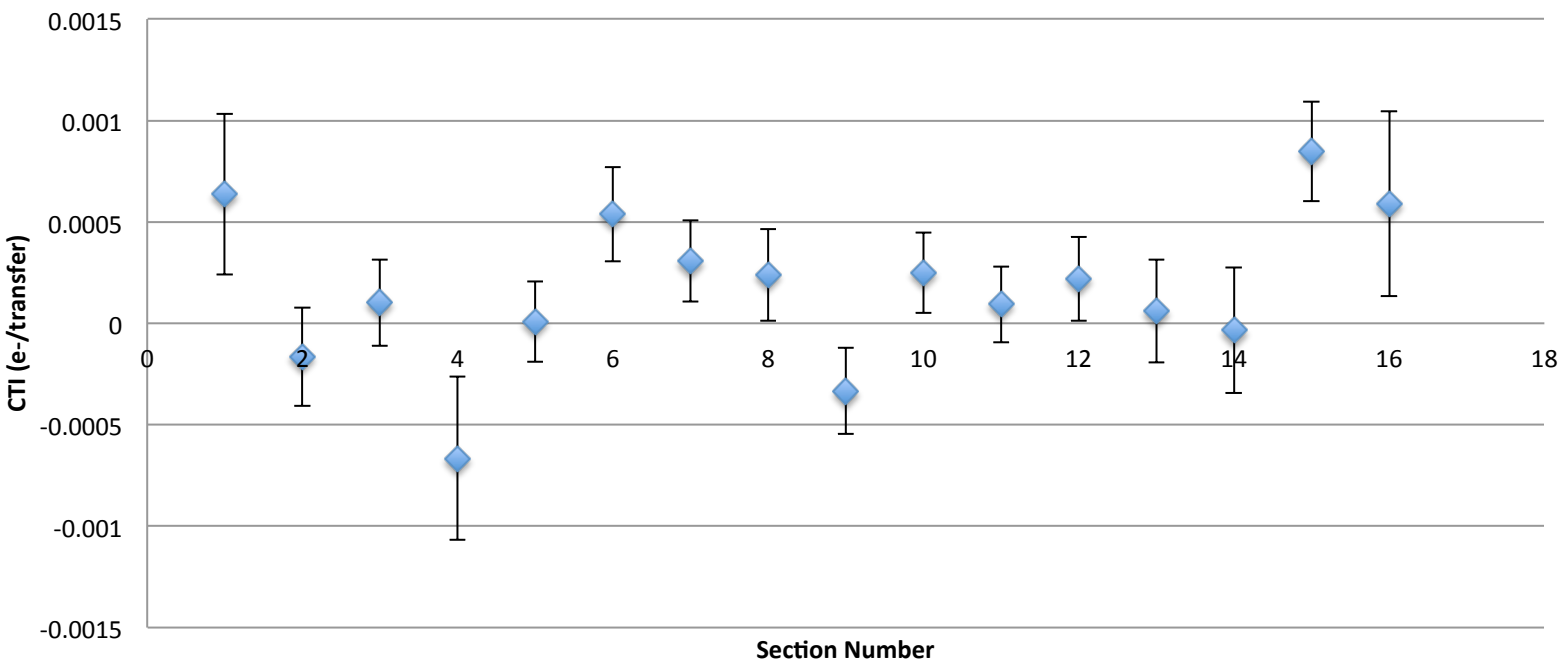








- Flux across sections 1-4
- E2v-113-03 files



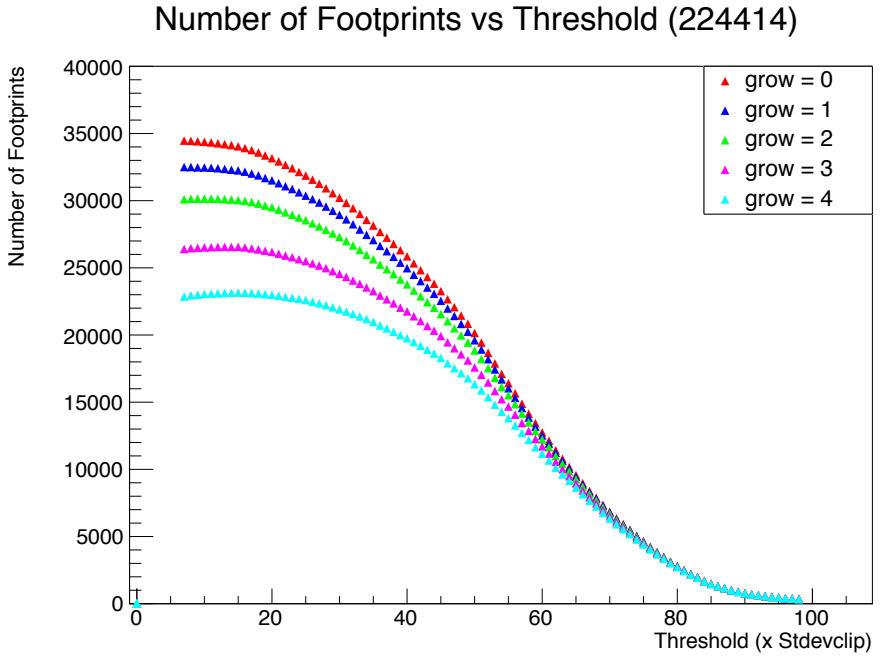
- Most exhibit CTI close to, but greater than, zero (preferred)
- Corresponding CTE values deviate in 4th or 5th decimal place
  - Most CCDs have CTE values deviate 6th or 7th decimal place

Section	CTE	Section	CTE
1	0.9994	9	1.0003
2	1.0002	10	0.9998
3	0.9999	11	0.9999
4	1.0007	12	0.9998
5	1.0000	13	0.9999
6	0.9995	14	1.0000
7	0.9997	15	0.9992
8	0.9998	16	0.9994

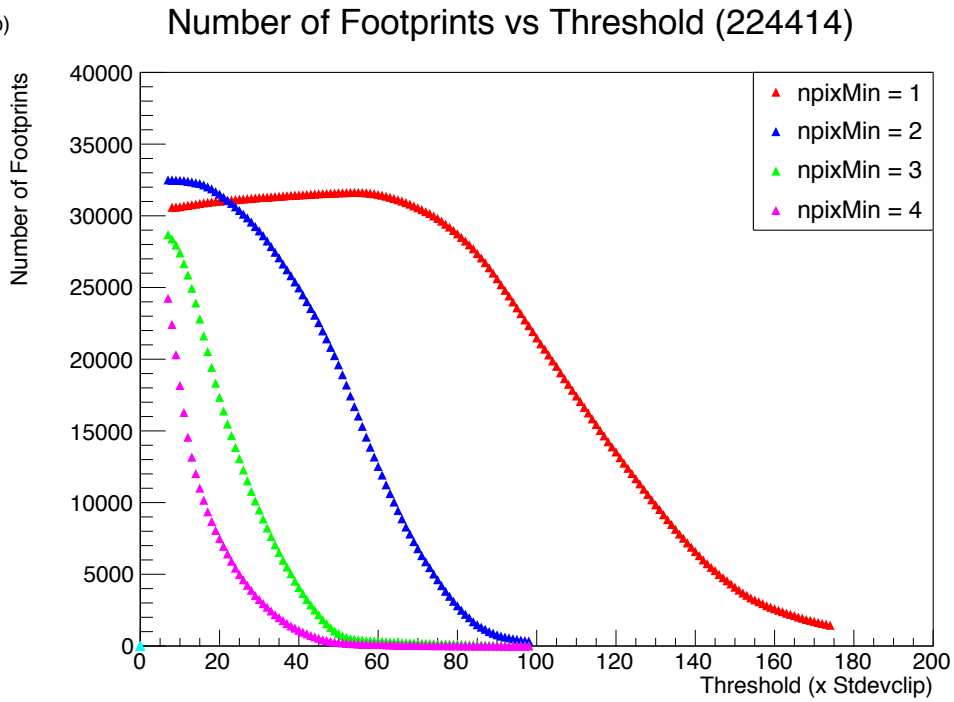
- E2v-113-03 files

Footprint Finder Parameters

- Method used to find footprints depends on four parameters
  - Threshold
  - Minimum pixel size
  - Growth factor
  - Isotropy
- Want to adjust those parameters to determine optimal settings for footprint finding in the detector
  - Sweep across threshold with different growth factors and minimum pixel sizes

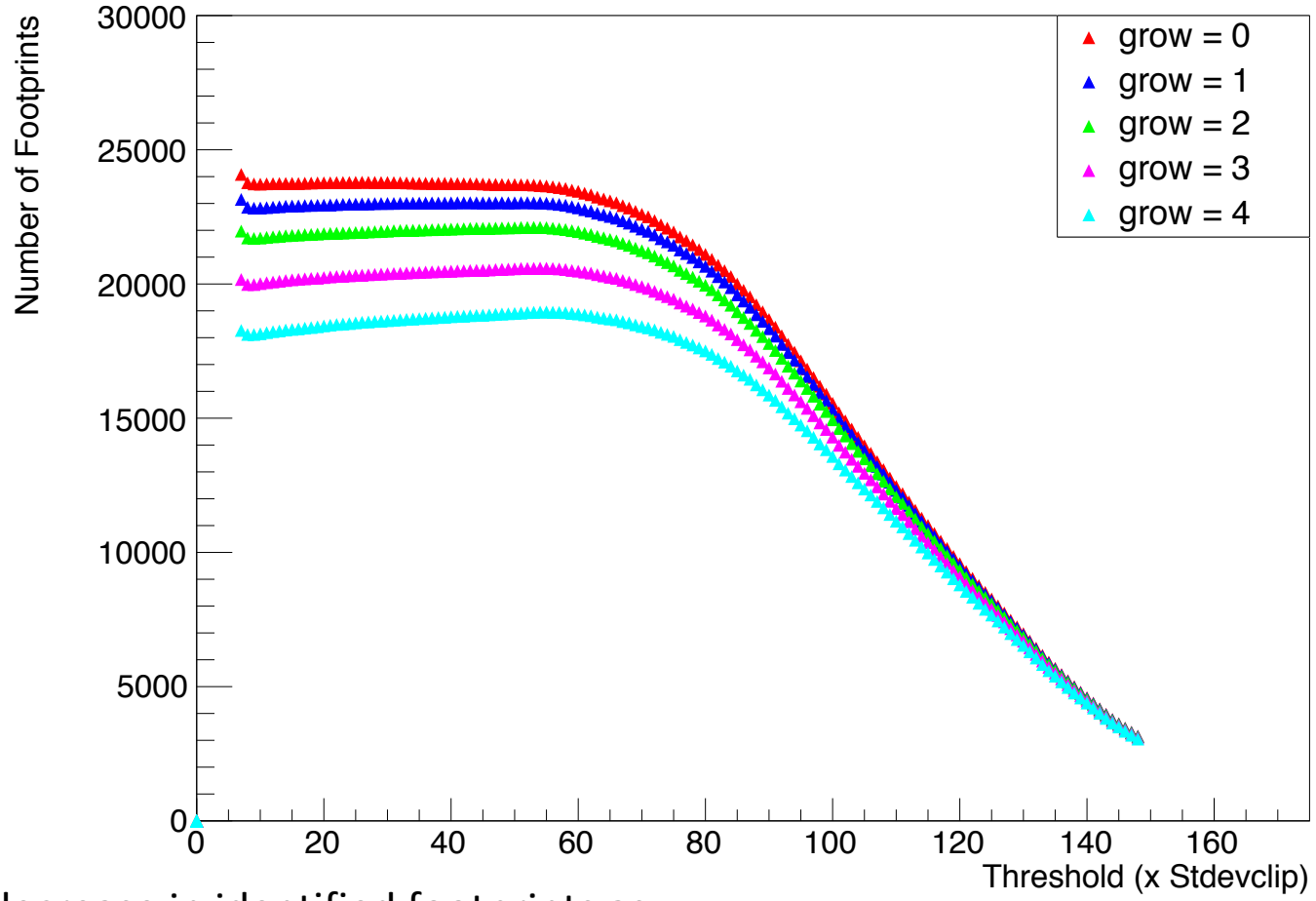


- Examining how grow parameter influences number of footprints
- Increasing grow decreases found footprints



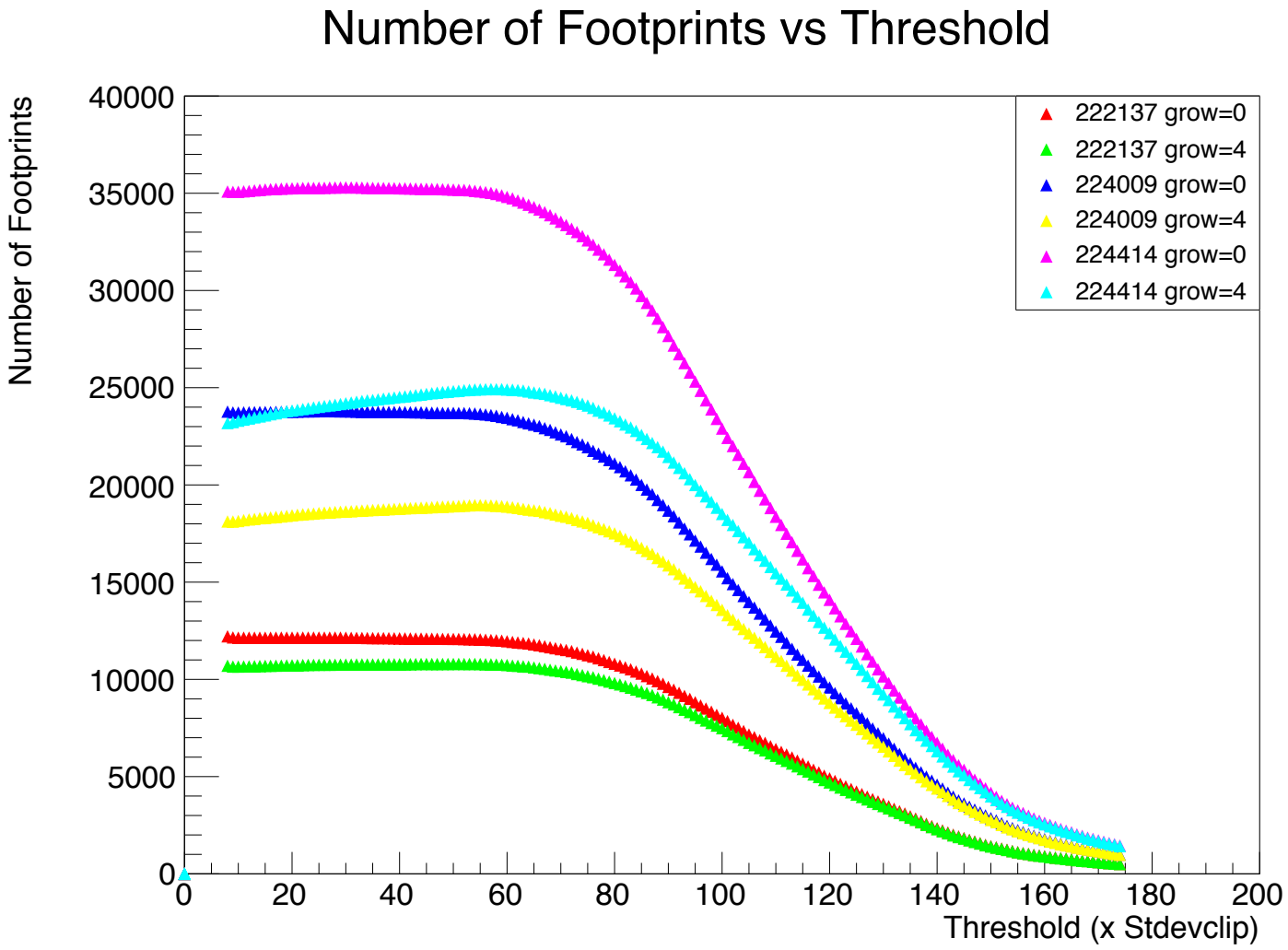
- Examining how minimum pixel parameter influences number of footprints
- Increasing minimum pixels decreases found footprints

- 113-03_fe55_fe55_015.00_000_20140709224414.fits file



- Same decrease in identified footprints as the grow factor increases
- Using 1 pixel minimum creates greater region of threshold independence

- 113-03_fe55_fe55_015.00_000_20140709222137.fits file



- Same relationship between grow factor and found footprints for the 3 exposure times present in data

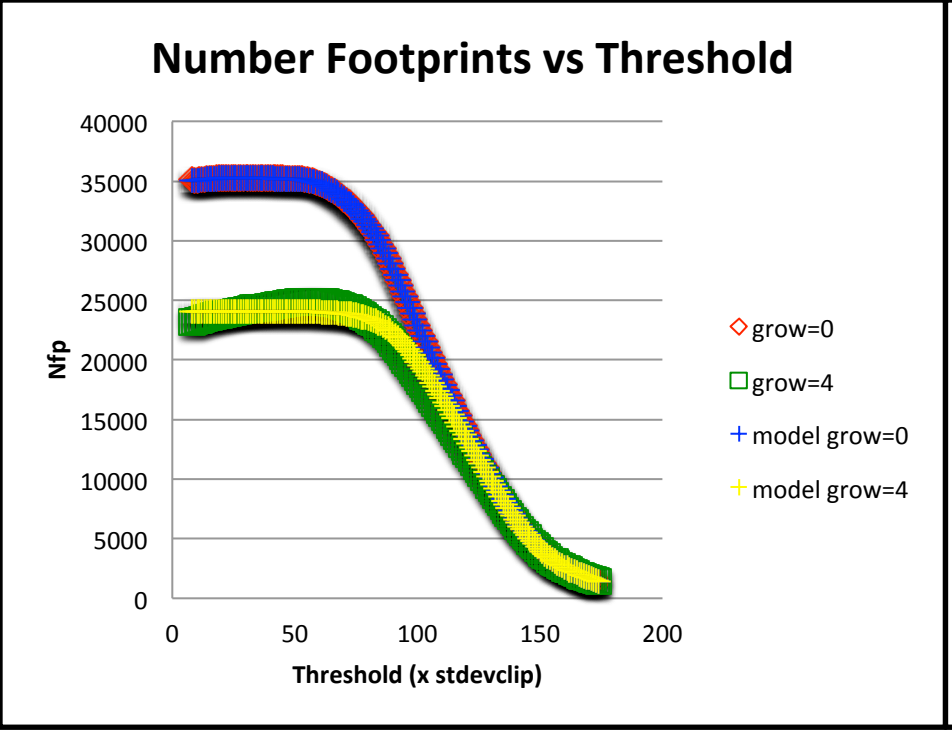
- 113-03_fe55_fe55_015.00_000_20140709222137.fits file, 113-03_fe55_fe55_015.00_000_20140709224414.fits file, 113-03_fe55_fe55_015.00_000_20140709224009.fits file

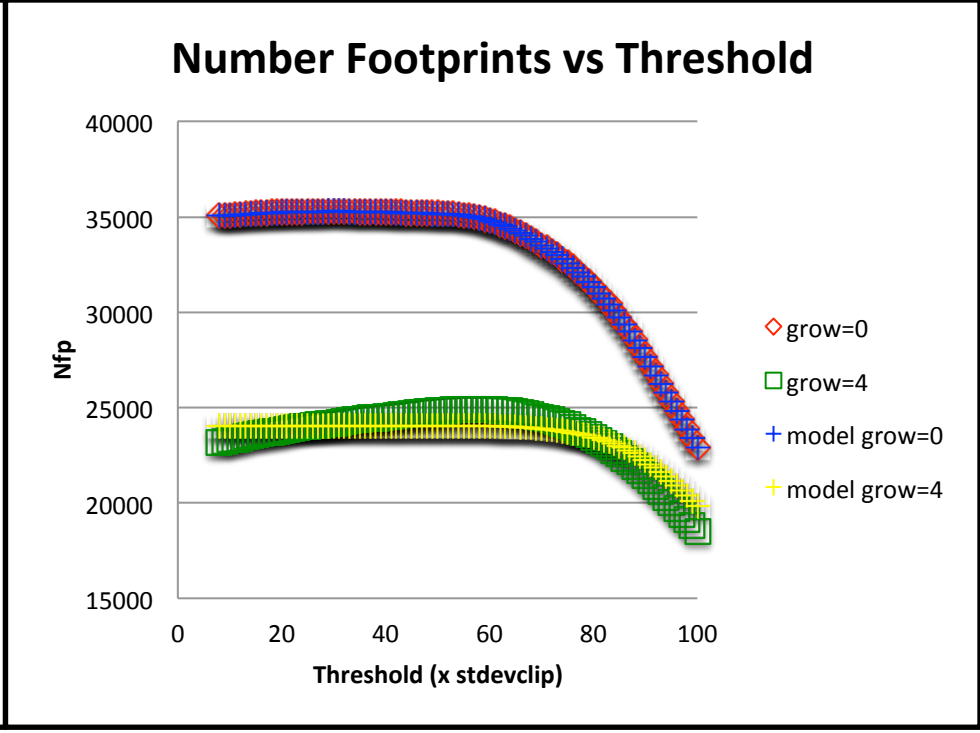
Modeling Footprint Falloff

- Currently attempting to model number of footprints as function of grow factor

$$N_{grow} = \left(1 - \frac{k(k-1)}{2}\frac{(2g+1)^4}{\left(\frac{N_{pix}}{5}\right)^2}\right) * k$$

- Where
  - k = number of footprints with g=0
  - g = growth factor





- Model fits very well to g=0 case (as expected)
- For g=4 case, model is multiplied by a (seemingly arbitrary) constant, β
  - β is different for g=2 case, and for different exposure rates

$$N_{grow} = \left(1 - \beta\left[\frac{k(k-1)}{2}\frac{(2g+1)^4}{\left(\frac{N_{pix}}{5}\right)^2}\right]\right) * k$$

- 113-03_fe55_fe55_015.00_000_20140709224414.fits file

Conclusion

- CTI analysis by dividing sections into bins shows that CTI is close to 0
  - Needs better statistics to ensure accuracy
- Minimum of 1, rather than 2, pixels gives large area of threshold independence
- Modeling footprints falloff with increased growth factor requires more work